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THE MINERALOGICAL SOCIETY

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EXCERPT MINUTES OF COUNCIL MEETING

Held at 116 *Victoria Street, June* 25*th*, 1885.

The Rev. Prof. Bonney, D.Sc., President, in the Chair.

Messrs. F. H. Butler and H. Robinson were elected members.

GENERAL MEETING

Held at the Rooms of the Philosophical Society, 207 *Bath Street, Glasgow, Tuesday, June* 16*th*, 1885.

Mr. John Young, F.G.S. (Visitor), in the Chair.

The following Papers were read :—

"On a New Locality for Barytes." By Thomas Wallace, Inverness (Communicated by the Local Secretary).

"On the Chemical Composition of some Samples of Graphite from Aberdeen." By W. Ivison Macadam, F.C.S., F.I.C., &c. Edinburgh.

"On the Chemical Composition of Butyrellite." By same.

"Analysis of a Sample of Strontianite from Strontian." By same.

"Notes on an Association of Minerals from Utah." By George S. Mackenzie, Ph.D.

"On Monazite and Connellite from Cornwall." By H. A. Miers, M.A.

(*Note on "Cone in cone" Specimens*).

Mr. John Young, F.G.S., exhibited a series of specimens and polished transparent sections of Cone in cone structures from the carboniferous strata of Western Scotland, and stated, that recently he had been led to make a careful examination of this peculiar structure in specimens that he had obtained at Waterland Quarry, Dunlop, Ayrshire. In these specimens the cone structure is well preserved, and the upward termination of the cones on the surface of the bed is so clearly displayed, that he has been led to form a different explanation as to the origin of the structure from any of those formerly advanced. He stated, that in the explanations of former observers, cone in cone had been ascribed to the action of various causes, such as chemical precipitation, the action of pressure on concretions in process of formation, and to a kind of crystallisation in the stratum after the deposition of the sediment of which the bed is composed. Mr. Young pointed out, that in his specimens there are revealed external characters and points of internal structure which apparently had not been recorded, or at all events had been overlooked in all the descriptions that had come under his notice. Briefly stated, the following are the chief conclusions to which he had been led. 1st. That Cone in cone was in all probability formed by the upward escape of gases, generated in the sediments in which it is found by the decomposition of the organisms present; these being either plant remains, Entomostraca, shells or fishes, as seen in the specimens exhibited. 2nd. That the cones start from a point near the lower portion of the stratum, and ascend upwards; their bases gradually expanding as they reached the surface of the bed. 3rd. That there exists in all the cones, large and small, a central axis or tube, through which the gases escaped that elevated the calcareous sediment in successive layers, and of which the cone structure is built up. 4th. That the transverse wrinkling, seen upon the inner surface layers of the cones, appears to be due to a creeping downwards through gravitation of the plastic sediment upon the slopes of the cones in the intervals between the ebullition of the gases that elevated the sediment. 5th. That a thin layer of clay of varying thickness is seen to exist between the several calcareous layers of the cones, and which was probably deposited from the waters in which the cone structure was being formed; and that it is owing to this layer of clay that the cones now, in most instances, separate readily from one another when the stratum is fractured vertically. Transparent sections also show that this layer of clay must have been deposited

within the cones whilst their bases remained open, the argillaceous layers being seen to unite with the central axis or tube. 6th. That coprolites of fishes, shells or other solid materials in the sediment are seen to have often interfered with the formation of the cone structure in their vicinity, and are sometimes found plugging up the orifice of a cone. 7th. That the cone structure was brought to a close in the stratum in which it exists by the gradual decrease of the gases that generated the mechanical action. In the Waterland specimens we find that the bases of the larger cones, where they terminate on the surface of the bed, are filled with groups of small minor cones, and that these continued in many instances to erupt sediment, layer within layer, until their bases now rise above the general level of the stratum, indicating that the last ebullition of the gases was small in quantity and very feeble. Mr. Young in conclusion stated, that his remarks, and the explanation he offered on cone in cone structure, were wholly founded upon the specimens and sections exhibited, and in these he thought it was clearly evident that the formation of the structure was contemporaneous with the deposition of the sediment, which, from the nature of the organisms, appears to have been deposited over the area of wide, shallow, freshwater lakes, either as a thin stratum, or in lenticular or nodular masses. He had carefully studied the specimens exhibited, in connection with the other explanations of the structure that had been recorded, but he failed to find in the chemical, crystalline, or concretionary theories, an explanation that would serve to illustrate the varied points of structure that are seen in the best preserved specimens of cone in cone from Western Scotland.

Note on Minerals exhibited.

Mr. D. C. Glen, F.G.S., exhibited a series of mineral specimens from the district around Glasgow, and from one or two other localities within the area of the Estuary of the Clyde, upon which he and the chairman made some remarks. The specimens consisted of examples of the group of Zeolitic minerals that are found in the basic olivine traps of the Kilpatrick and Renfrewshire hills, and embraced crystallised varieties of prehnite, analcite, laumontite, natrolite, Thomsonite, stilbite, heulandite, chabasite, &c. Mr. Glen also exhibited specimens of native copper from the trap of Boyleston Quarry, Barrhead, and some crystals of the rare mineral Greenockite from the trap of the Bishopton Tunnel, also specimens of the Arran pitchstones, and spherulites, from Corriegills and Invercloy.

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No. 30. AUGUST 1885. Vol. VI.

On the Physical and Geometrical Properties of Graphite.

By Hj. Sjögren. Communicated by H. Müller, Ph.D., F.R.S.

[Read March 10th, 1885.]

E. D. CLARKE was the first mineralogist by whom crystallised graphite was observed and examined. As early as 1821,* he described some graphite crystals from the mines at Borrowdale, in Cumberland. Clarke designated graphite by the name of "carburet of iron" or "plumbago," and stated its form to be that of an oblique four sided prism, the obtuse angle of which was found by measurement with the contact goniometer ("the common goniometer") to be 118°.

Since then crystallised graphite has been examined by several mineralogists. Haidinger† and Kenngott‡ have pronounced the system of axes to be hexagonal, but Nordenskiöld,§ who has made the most complete research, is of Clarke's opinion, that the system of crystallisation is monoclinic. The determinations of Nordenskiöld have been most generally accepted, and quoted in most manuals. In the present paper the twins of

* *Annals of Philosophy*, New Series, vol. ii. p. 417.

† *Handbuch der bestimmenden Mineralogie*, p. 513, 1845.

‡ *Sitzungsber. d. math. naturw. Classe der Wiener-Akad.* vol. xiii. p. 469, 1854.

§ *Pogg. Ann.* vol. xcvi. p. 110, 1855.

graphite, its gliding-faces "*Gleitfläche*," its percussion-figures, the nature of its etching-figures, and its relative conduction of heat in different directions will be described. The numerical values of the angle measurements made by me have been left out of this brief paper, as they have not led to any unequivocal result; with regard to several other points, the reader is referred to my more detailed account in "Ofversigt af Kongl. Svenska vetenskaps akademiens förhandlingar," p. 29, 1884. The material that I have made use of consists of natural crystals from Ceylon, and from Pargas in Finland, and artificial graphite from some furnaces in Wermland.

Angle Measurements.

In computing the angle measurements carried out on six crystals, the most importance is attached to those angles which are situate in the plane of the cleavage surface, *i.e.* the so-called horizontal angles. If the system of crystallisation be hexagonal, the values 60° and 120° must be met with among these angles. The computations showed that the angles in question always deviated somewhat from the above values, and that the variations amounted to above 2° towards each side.

In order to check these results, direct measurements were executed of those plane angles which are formed on the basal plane by the striæ running in three directions, and forming triangles on the cleavage surface. Those angles were measured under a microscope provided with a capillary cross and movable stage.

The measurements could be performed with great accuracy, and the degree of accuracy was checked by means of measuring the three angles of the same triangle. It appeared from measurements executed on five crystals, that the angles varied quite irregularly from 61°40′ to 57°16′. If the largest, mean, and smallest angles of the same triangle are denoted respectively by α, β, and γ, we find the values of α to vary from 61°40′ to 60°6′; those of β from 61°24′ to 59°18′; and those of γ from 59°53′ to 57°16′. Sometimes *two* angles of the same triangle are above 60°, and the third below; sometimes only *one* angle is larger and both the others smaller than 60°.

The variation in each of the angles α, β, and γ, is considerably greater than can be explained by errors of measurement, for while the errors of the sum $\alpha + \beta + \gamma$ do not exceed 0°16′, the variations in α are 1°34′, in β 2°6′, and in γ 2°37′.

From these facts it seems quite evident that the angles between the three crystallographic directions represented by the systems of striæ are not constant, but subject to considerable variations. It is thus easy to

understand why other angles also manifest an equal want of constancy. This variableness of the plane angles as well as of solid angles agrees with the results of previous investigations of graphite. For neither can the measurements obtained by different authors, as Kenngott, Haidinger, and Nordenskiöld, be brought into accordance with one another, nor even the angles measured by Nordenskiöld on different crystals be reduced to the same system of axes.*

The three angles of the basal plane varying irregularly from 60°, the crystallographic development evidently presents no obstacle to the mineral being regarded as hexagonal. But in order to arrive at a surer determination of the system of crystallisation, the physical properties of the mineral must be inquired into, and after having described its twins we shall pass over to that part of the subject.

Twins.

Although the striæ of the basal plane have been mentioned by all authors who have occupied themselves with this mineral, no one has investigated their nature. I have found them to consist of ridge-like elevations. These ridges are enclosed either by three planes, two of which form the sides of the ridge, and the third, parallel to the basal plane of the principal crystal, truncates the edge of the ridge; or else by only two planes that intersect at the edge of the ridge.

On cleaving the crystal scales, the ridges are found not to lie above the basal plane, but each ridge goes down into the crystal itself (figs. 1 and 2).

Fig. 1.

Fig. 2.

The cleavages of the ridge are parallel to its sides, and form obtuse angles with the corresponding cleavages of the crystal scale.

It is easy to measure the re-entering angle A between the sides of the ridge and the basal plane.

The mean value of a great number of measurements of crystals from Pargas and Ceylon is—

$$A = 159°32'$$

The plane bisecting this angle is a plane of symmetry with regard to both the elements of the crystal, and accordingly a twinning-plane. Its inclination B to the basal plane is—

$$B = \frac{360° - A}{2} = 100°14'$$

* *Pogg. Ann.* vol. xcvi. p. 110, 1855.

Being a twinning-plane this plane must be a real or potential crystal surface; it is, in fact, a real crystal plane occurring in crystals both from Pargas and Ceylon.

On examining the ridges more closely, they are in general found to be constructed of three differently arranged crystal elements, two of these forming the sides of the ridge, and the third its edge (fig. 4). Other ridges consist of only two elements (fig. 3). The middle element 1 *b*, imbedded between the lateral elements, is situated parallel to the crystal 1*a*, and ought accordingly to be regarded as forming part of this. It is evident that the elements 1 *b* and 2 have the same position with regard to each other as 1 *a* and 2, and that in both cases the same plane, the pyramid plane *P*, is a twinning-face. Of course, there is the same twinning law also between the elements 1 *b* and 3, and 1 *a* and 3. On the contrary, the twinning law between the elements 2 and 3, which are symmetrically situated with regard to a vertical plane, is a different one. This plane, which is thus also a composition face, is a pyramid surface $\frac{1}{2}P$, the vertical axis of which is half as long as that of the other composition face.

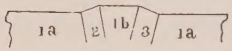


Fig. 4.

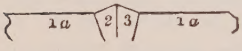


Fig. 3.

Thus the ridges are constructed of two differently arranged crystal elements, without counting the principal scale itself. Within every ridge twinning has taken place according to two different laws.

It is not without interest to consider how these twins are to be regarded, according as the graphite is supposed to crystallise in the hexagonal, rhombic, monoclinic, or triclinic system. While the three directions of the ridges are equal, if we suppose the system of crystallisation to be hexagonal, it is seen by a simple deduction that with the other systems two or even all the three directions become unequal in value. With those systems of crystallisation which are less symmetrical the twins accordingly become more complicated. If the crystal form is supposed to be hexagonal, the crystal-complex is constructed according to two twinning laws; if it is supposed to be rhombic, according to four; if it is supposed to be monoclinic, according to six or nine different laws, according as the cleavage is supposed to be parallel or at right angles to the plane of symmetry; and lastly, if the crystal form is supposed to be triclinic, nine different twinning laws must also exist.

Gliding-faces and Artificial Twins.

In many minerals with very distinct cleavages in one or more directions,

i.e. with very different degrees of cohesion in different directions, there occur gliding-faces. Such are known to exist in mica, calcite, soda-nitre, cyanite, galena, gypsum, stibnite, bismuthite, and orpiment. The graphite, which has such a distinct cleavage, is also found, in analogy with the above-mentioned minerals, to possess this kind of structural faces. The existence of gliding-faces is proved by bending crystal scales cautiously, as ridge-like striæ then appear strictly analogous to the natural ridges produced by twinning.

Thus, by means of the gliding-faces, it becomes possible to produce artificial twin crystals of graphite, just as artificial crystal twins of calcite may be produced, which have $-\frac{1}{2}R$ for their twinning-face.

We have designated P and $\frac{1}{2}P$, the faces occurring in the ridges, as twinning-faces, and it has been shown that the same symbols are those of the gliding-faces.

On bending a crystal scale the ridges are formed on the concave side and spring out in three directions, which, as we have seen before, make angles of about 60° with one another. The stronger the bending is, the higher and more numerous they become. It is clear that the line *a b c d e* is equal in length to the line *a′ b′ c′ d′ e′* (fig. 5). If the crystal scale is bent back so as to become plane, or so as to make that surface convex which was before concave, the ridges partly maintain themselves, and new ones arise on the other side that was concave before, but is now plane or convex. This proves that there is a degree of stability in the new state of equilibrium of the molecules comparable to the stability of the molecules in their normal state. Thus by repeatedly bending the crystal scale in both directions ridge-like elevations are produced on both sides of it (fig. 6).

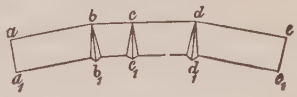


Fig. 5.

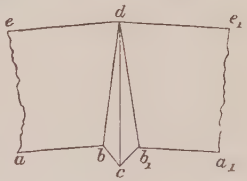


Fig. 6.

If such a scale is pressed between paper, the ridges recede and vanish completely, a gliding or turning of the molecules taking place in the opposite direction, so that they resume their normal position. If the scale is bent, the ridges come forth again in the same places as before.

Percussion-figures.

The percussion-figures exhibited by the graphite after suitably arranged experiments are closely connected with the gliding-faces and the twinning. Such figures are very easily produced on natural crystal scales

as well as on artificial graphite. According to the nature of the material the conditions of the experiments must be somewhat varied, for instance the firmness of the substratum, the sharpness of the point, &c.

If such a scale is chosen for the experiment as is free, as much as possible, from the ridge-like striæ, such striæ will generally be found after the experiment, radiating from the hole into which the point has penetrated. The percussion-figure consists of these striæ that run out in three directions, forming a percussion star with six or three rays (fig. 7). The percussion-figures produced are in general not very regular; the directions of the ridges are certainly always constant, but the ridges are not equal in size. On the contrary, in the same star they present many variations with respect to the height, breadth, and length of the rays. In numerous experiments these variations have been found to be altogether irregular, so that there is no reason to suppose that the unequal ridges denote crystallographic directions of different values.

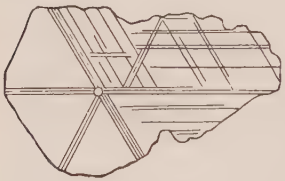


Fig. 7.

If the crystal scales are thin and firm, for instance in furnace graphite or Cingalese graphite, it is advantageous to employ a hard substratum, such as glass. One then gets small, fine, and regular stars, which are best seen in a microscope, magnified about 70 diameters. If the scales are thicker and softer, for instance in Pargas graphite, no percussion-figures are effected with a glass substratum, but only round holes. In this case softer substrata, wood or paste-board, are used with advantage; by that means percussion-figures are obtained that are large, coarse, and irregular, and best to be seen with the naked eye or with a lens.

The percussion-figures of graphite are of quite a different nature for instance to those of the micas. In the last named mineral a rupture takes place, so that the connection between the molecules in certain directions is broken. In graphite no rupture is ever to be perceived, but only a dislocation. The percussion-figures of this mineral may be altogether referred to the gliding-faces mentioned above. While the percussion-figure of the micas shows in what direction the cohesion is at its minimum with regard to a certain kind of action, the corresponding figure in graphite shows in what direction the resistance against gliding is at its minimum with regard to the same kind of action.

Cohesion.

The cohesiveness of graphite and the cleavages dependent thereon

differ very much in different varieties. In furnace-graphite the cleavage parallel to the basal plane is much less distinct than that in the natural varieties.

The statements in different manuals of mineralogy as to the other cleavages do not at all accord with one another. Tschermak and Naumann-Zirkel mention prismatic cleavages besides the basal. Descloizeaux, on the contrary, records cleavages parallel to Kenngott's fundamental rhombohedron, while Dana does not mention any other cleavage than the basal one.

An examination of Cingalese graphite has proved it to possess no other cleavage than the basal one; on crystal scales being torn asunder by forces parallel to the basal plane, the rupture takes place either quite irregularly or else along gliding-faces and twinning-planes. Pargas graphite agrees with it in this respect.

Combustion and Etching Figures.

The etching-figures of graphite have a very great interest, because they supply us with a better guidance than any other properties of the mineral in determining the system of crystallisation.

In order to produce etching-figures in graphite, the mineral may either be heated in a current of dry oxygen or treated with a mixture of potassium-chromate and sulphuric-acid. By both methods the same sort of etching-figures are obtained.

Graphite is burnt with difficulty; even in a finely disintegrated state it burns with more difficulty than diamond. It being necessary to employ whole crystal scales in order to obtain combustion-figures, the resistance to combination is still more considerable, and one is obliged to use strong heating and much oxygen. It is on furnace-graphite that combustion-figures are most easily produced.

By suitably arranged experiments, small but sharp and distinct etching-figures with marked symmetry are obtained. If the temperature is too high, or the heating is continued too long, the etching-figures become large, their limits uneven, and their shape approaches more and more that of a circle. A crystal scale that has been exposed to such action is lacerated and torn at its edges and perforated in many places by holes 0·1—0·3 mm. in diameter, which are generally round, but sometimes show a tendency to the hexagonal form.

In a great number of experiments the most beautiful combustion-figures were obtained on artificial graphite that was etched in a current of oxygen during one minute.

On being examined with a microscope the combustion-figures were found to occur rather sparsely, and to be small but sharp and distinct. They were extremely regular hexagons 0·003—0·105 mm. in diameter. If the same sort of graphite was etched during 2½ minutes in a current of oxygen, it was covered with numerous combustion-figures, partly larger and expanded, partly smaller and deeper. Their form was generally round, or irregular with notched edges. In some places the figures joined into parallel rows, that were at right angles to one of the directions of the striæ. In other places the preparation was perforated; the holes were hexagonal. There were also found on the same preparation very fine etching-figures, visible only when highly magnified; these formed extremely regular hexagons 0·012—0·015 mm. in diameter, with only slightly rounded corners. The sides of the hexagons coincide with the three directions of the striæ (fig. 8).

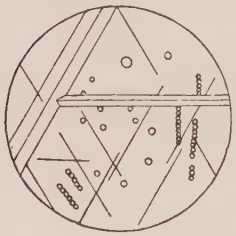


Fig. 8.

The same result was obtained on the natural graphite from Pargas and Ceylon.

If the etching is effected by means of a mixture of potassium-chromate and sulphuric-acid the figures always become hexagonal, unless the attack is so violent that they become round or quite irregular.

The nature of the combustion-figures and etching-figures of graphite affords a strong reason to regard the mineral as hexagonal, because, as far as we know at present, the symmetrical properties of the etching-figures are very intimately allied with the system of crystallisation.

It is interesting to compare graphite in this respect with a group of minerals that is closely related to it in external and even some physical properties, viz. the micas. They agree with graphite in the distinct basal cleavage and the pseudo-hexagonal habit shown by their crystals, but, inasmuch as they belong with certainty to the monoclinic system, they differ from it by giving on the basal cleavage etching-figures the symmetry of which is in general *not* hexagonal.

Conduction of Heat.

In order to ascertain the system of crystallisation in another way, the melting-curve of the basal plane was examined.

Senarmont's method, as it has been modified by V. von Lang, was employed, as well as that indicated by Röntgen. The former method seems to be more convenient for graphite, as it allows one to make the

diameter of the curve larger. The curve was regular and sharp until it reached a size of about 4·5 mm.; larger curves showed great irregularities, on account of the wax being liable to melt at the same time over the whole crystal after the curve had attained that size.

The melting-figures obtained appeared to the naked eye as perfect circles. In order to determine their form more accurately, their diameters were measured in three different directions parallel to the three directions of striæ, accordingly making angles approximately of 60° with one another. The measurements were made with a dividing instrument belonging to the Physical Institution of the University of Upsala; with that instrument lengths might be read off as near as $\frac{1}{1000}$ mm. It resulted from this examination that the melting-curve is a circle, if such casual irregularities are disregarded as are called forth by heterogeneity or unevenness of the wax layer. This result, as well as several of the physical properties set forth above, denotes the hexagonal system of crystallisation.

Summary.

We here put together the results obtained by the above examination of the physical and geometrical properties of graphite.

1. The striæ or ridges occurring in graphite crystals from different localities arise from twinning, which takes place in every ridge according to several different laws. If the mineral is supposed to crystallise hexagonally, two twinning laws suffice to explain the structure of the crystal-complex; whereas on the supposition of a less symmetrical system of crystallisation, this twinning becomes far more complicated.

2. The same sort of twin crystals as the natural ones may be artificially produced by bending crystal scales; thus it is evident that those surfaces which are twin-planes are also gliding-faces.

3. The percussion-figures of graphite may be referred to the gliding-faces, and are of another kind than the percussion-figures of micas and many other minerals.

4. The solid angles of graphite as well as the plane angles on the cleavage, show so little constancy that the geometrical structure of the mineral cannot be employed to determine the system of crystallisation.

5. The combustion- and etching-figures are regular hexagons.

6. The melting-curve of the cleavage is a circle, as far as can be ascertained by means of the methods that have been used.

7. *The nature of the twinning, together with the etching-figures and the melting-curve, make it probable that graphite crystallises in the hexagonal system. This is not contradicted by its geometrical properties, which are too inconstant to form the ground of any decision on this point.*

Notes on a Recent Discovery of "Connellite."

By W. Semmons.

[Read March 10th, 1885.]

THE gradual decline in the production of copper from the mines of Cornwall and the consequent diminution of their number renders any discovery of a rare copper mineral an object of interest to all mineralogists.

Owing to the exhaustion of all the upper deposits, those products of decomposition—the beautiful arseniates and phosphates, &c. which adorn the cases of our national collection and those of private collections—are getting more and more scarce, and perhaps in the near future, so far as Cornwall is concerned, we shall have to rely for illustrations entirely on its past productions.

Probably one of the most beautiful of these minerals was the rare species "Connellite," a sulphato-chloride of copper found in small crystals of a deep blue colour, in copper veins traversing clay slate at Huel Providence and Huel Unity, also in a vein at Huel Damsel traversing granite. Huel Unity was a perfect storehouse of copper minerals, no less than fourteen combinations of that metal being found there, some of them being crystallised better than in any other mine; so that we might naturally look for good illustrations of Connellite here if any where.

Rashleigh in 1802 seems to have noticed the mineral from Wheal Providence, as a copper ore of an azure-blue colour composed of needle crystals.

Phillips in his 1823 edition does not, however, notice it.

Connel (Report British Association, 1847) gives an interesting account of its composition; while Dana, 1850, gives it a specific name.

Professor Maskelyne's paper (*Phil. Mag.* Jan. 1863) gives us by far the greatest information on the mineral, and one cannot help admiring the skill with which crystals of such minute size are there figured and described.

Bertrand has since (*Bull. Soc. Min.*, 1881, IV.) determined the mineral as optically uniaxial and positive.

Our knowledge of the mineral being therefore derived from very scanty material and from such old specimens, a detailed description of it from a new find in the Camborne district seems warranted. I have ventured too to give a detailed description of the associated minerals, and am able

to do this more fully than usual, as, owing to the miners not knowing Connellite, they have put aside specimens of other ores mistaking them for it. We owe our knowledge of this recent discovery largely to the energy of a local mineral dealer, Mr. Wm. Peters of Redruth.

The Camborne district is situated at the western end of the boss of granite in which most of the productive tin mines of the county are now worked. On the west and north flanks of this lies the killas (clay slate) for a distance of several miles, when we again meet with other outcrops of granite.

Like many other minerals which owe their existence to a peculiar combination of conditions, "Connellite does not seem to occur massive, and the little patches that appear compact resolve themselves into a mass of minute crystals. These are generally in radiating and divergent groups, but single crystals are occasionally found standing out distinct and alone."

Dr. Ch. O. Trechmann informed me he was not able to discern the di-hexagonal pyramid of Maskelyne under the microscope even with a power of 35. Dr. Trechmann has, however, since forwarded me a note giving a detailed description of the crystallographical characters of the mineral in two specimens I sent him. As mere extracts therefrom would in my opinion simply spoil the value of this note, I append it in full at the end of this paper.

In one specimen (received since Dr. Trechmann's examination) the crystals are so large that a hand lens of very low power enables one to determine their forms. I notice that we have here only the hexagonal pyramid and the di-hexagonal prism. The faces of the pyramid are unequally developed, some planes being developed at the expense of others as in some quartz crystals.

I am informed that a specimen in the collection of the Museum of Practical Geology also shows this almost complete obliteration of alternate planes.

The colour of the specimens I have seen is blue of various shades. In the well formed and larger crystals we have, when light passes through them, the most charming tints thrown up, and equalling the hues of the finest sapphire.

The other physical characters agree with those given in Dana, *System of Mineralogy*, page 627, as belonging to Connellite.

Associated with Connellite we have crystals of Brochantite of simple form, also very beautiful crystals of chalcophyllite; also cuprite, malachite, azurite, chalcocite and chalcopyrite.

The better way of describing their associations is perhaps to detail the way in which the minerals are found in the specimens produced.

No. 1.—The main mass of the stone consists of massive cuprite, which has been cut into patches by strings of malachite and Brochantite. On the upper surface are octahedral crystals of cuprite, and in sundry small cavities very well defined crystals of Brochantite. In some cases lying directly on the cuprite, and in other cases interlacing and covering the Brochantite, are transparent crystals of Connellite.

No. 2.—Crystals of cuprite (rhombic dodecahedra with slight development of octahedral faces) have a patch of Connellite crystals lying directly on them.

No. 3.—Compact mass of cuprite with traces of decomposition therein to only a small extent. The upper surface is covered with a layer from $\frac{1}{2}$ to $\frac{3}{4}$ inch thick composed of a mixture of compact and crystalline Brochantite with occasionally well defined crystals of the same mineral. Scattered over the surface and also in small cavities are well formed transparent crystals of Connellite.

No. 4.—A mass of compact cuprite, on which there is a small patch of malachite. This is covered in places with minute crystals of Connellite of a charming deep blue colour.

No. 5.—A most interesting stone; the main portion being cuprite, on and in which are malachite and Brochantite, some crystals of the latter being most distinct and perfect. On some undecomposed cuprite crystals are two radiating clusters of Connellite crystals having their terminal planes (hexagonal pyramid) beautifully developed. The crystals from centre of radiation to apex of pyramid are about $\frac{1}{4}$ inch in length, so that their form can be distinguished by the naked eye. The Connellite crystals too are found filling up the interstices between sheaves of radiating Brochantite crystals.

No. 6.—A stone almost entirely composed of azurite and malachite with cuprite. On the malachite is a layer of minute crystals of Brochantite, while a few very small crystals of Connellite are scattered over the stone.

No. 7.—Some minute radiated tufts of Connellite with malachite. Also some distinct crystals of chalcophyllite (copper mica) mixed with the malachite. In one small cavity there are pseudomorphs of malachite after chalcophyllite, the external cast only remaining as the interior is quite hollow. No cuprite found, but in its place copper pyrites.

No. 8.—Very beautiful and well defined hexagonal prisms of chalcophyllite on a base of chalcocite. The latter mineral is much decomposed. Again no trace of cuprite.

No. 9.—Decomposing chalcocite with radiated layers of small but brilliant crystals of chalcophyllite. Again no cuprite. We meet, too, here

with little tufts of minute bluish-green crystals which are probably Connellite.

The result of the above examinations tends to show that Connellite is most frequently associated with cuprite, Brochantite too being almost always present. The mineral, though, also occurs with chalcophyllite, but not so frequently.

We notice that chalcophyllite is found rather with the sulphides chalcocite and chalcopyrite, than with the oxide, cuprite.

Through the kindness of Mr. Thos. Davies, F.G.S., Mr. F. W. Rudler, F.G.S., and Mr. Pringle, I have, during the preparation of these notes, been able to examine the new and old specimens of Connellite in the National Collection at South Kensington, the Ludlam Collection and the Collection of the Museum of Practical Geology. I find the associated minerals with Connellite here also to be cuprite and Brochantite. Connellite in very minute crystals has recently been found in some stones from Marke Valley Mine, which is situate in the Eastern part of Cornwall, and therefore a long distance from any of the previously known localities. I have not been able to examine many of the Marke Valley specimens, but the general appearance of those I have seen is similar to those raised in the Camborne district.

The peculiar resemblance of the Brochantite to that from Peru, which I described to this Society (see *Mineralogical Magazine*, Vol. IV. p. 260), much interested me. There is also found frequently a peculiar amorphous-green copper mineral which gives reactions for both carbonate and sulphate, just as in the Peruvian specimens.

The Peruvian Brochantite was associated with decomposing Atacamite. Although I have not yet seen any trace of Atacamite in the Cornish specimens, it would not at all surprise me if we should find the Connellite has derived its chlorine from this mineral.

In conclusion, I trust that as probably sufficient materials are at hand, we may soon have presented to us a full and complete analysis of this rare and interesting combination.

On Monazite from Cornwall, and Connellite.

By H. A. Miers, M.A.

Monazite from Cornwall.

[Read June 16th, 1885.]

A SPECIMEN of crystallised quartz and albite has recently been acquired for the British Museum which has a few isolated crystals of this rare mineral dispersed upon it. Conclusive evidence that the specimen comes from Cornwall is supplied both by the appearance of the quartz and albite and by the presence of the clay-slate with which they are associated.

The mineral monazite or Turnerite has hitherto been discovered in few localities and never in the British Isles. Anatase, however, is mentioned in Greg and Lettsom (*Manual of the Mineralogy of Great Britain and Ireland*, p. 363) as occurring at Tintagel and near Liskeard in Cornwall; and it is just possible that crystals of monazite may have been mistaken for anatase. Even if anatase has been found, it may be observed that the presence of one of these minerals is a ground for suspecting that the other may possibly occur in the same locality, as has been remarked by Hessenberg. Sphene, for which monazite might also have been mistaken, is not recorded from Cornwall; the specimen here described was detected by Mr. Davies as a new Cornish mineral, but was supposed to be sphene.

The crystals of monazite are approximately rectangular tables of the form shown in fig. 1, of a yellowish-brown colour. They are mostly from 1 to 2 mm. in length and breadth, and from $\frac{1}{2}$ to 1 mm. in thickness, and are thinly dispersed on one side of the specimen upon crystals of albite which overlie the quartz. In one instance, however, monazite is actually included in a crystal of quartz.

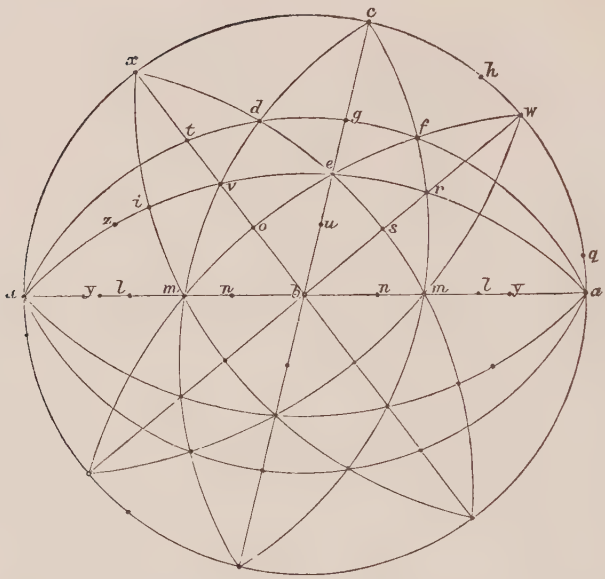
The following is a complete list of the forms which have been found upon Turnerite or monazite, including two new faces observed for the first time upon these Cornish crystals. A projection is given in fig. 1. (See p. 166.)

In addition to the well-determined faces given in this table, Phillips found two faces between *am* and *bm* respectively, and E. Dana, *American Journ. Scien.* xxiv. 1882, p. 247, found three between *sv*, *sv'* (121 : 11$\bar{1}$), and *re* respectively, to which definite indices cannot be assigned.

		I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	
100	$\infty \breve{P} \infty$	p	P	P	M	a	c	p	a	c	
010	$\infty \breve{P} \infty$	g_1	K	K	P	b	b	g_1	b	b	
001	$0\,P$					c			c		
011	$\breve{P} \infty$	m	M	M	e	e	m	e_1	e	m	
021	$2 \breve{P} \infty$	g_3	l			u	l	g_3	u	l	
012	$\frac{1}{2} \breve{P} \infty$	h_3	i				i	h_3	g	i	
101	$-\breve{P} \infty$	o_1	a	a	e^1	w	u	o_1	w	u	
$\bar{1}01$	$\breve{P} \infty$	a_1	c	c		x	x	a_1	x	x	
305	$-\frac{3}{5} \breve{P} \infty$										Trechmann, Neues Jahrb. 1876, p. 593.
110	∞P	e_1	e_3	e	$\underline{e}$	m	e	m	M	e	
210	$\infty \breve{P} 2$	e_2	e_1		$\breve{a}$		v	e_2	l	v	
310	$\infty \breve{P} 3$								y	n	
120	$\infty \breve{P} 2$		e_5		$\underline{e}$	n			n	o	
111	$-P$		f		$\underline{a'}$	r		$d\frac{1}{2}$	r	z	
121	$-2\breve{P} 2$				$\underline{o'}$	s			s		ω of E. S. Dana.
$\bar{1}11$	P	$b\frac{1}{2}$	g_1			v	r	$b\frac{1}{2}$	v	r	
$\bar{2}11$	$2 \breve{P} 2$							b_1	i	t	
$\bar{3}11$	$3 \breve{P} 3$	$b\frac{3}{2}$					s	$b\frac{3}{2}$	z	s	
$\bar{1}21$	$2 \breve{P} 2$	e_3	e_6				w	w	o	w	
$\bar{1}12$	$\frac{1}{2} P$								d		
$\bar{2}12$	$\breve{P} 2$								t		
112	$-\frac{1}{2} P$										
701	$-7\breve{P} \infty$										

I. Lévy. Annals of Philosophy, xxi. 1823, p. 241.
II. Phillips. Mineralogy. 3rd Edition, 1823, p. 382.
III. Brooke. Philosophical Magazine, x. 1831, p. 189.
IV. J. D. Dana. American Journal of Science, xxxiii. 1838, p. 70.
V. Miller. Phillips' Mineralogy, 1852, p. 493. (Monazite.)
VI. Miller. Phillips' Mineralogy, 1852, p. 653. (Turnerite.)
VII. Descloizeaux. Manuel de Minéralogie, i. 1862, p. 533.
VIII. Kokscharow. Materialien zur Mineralogie Russlands, iv. 1862, p. 8.
XI. Vom Rath. Poggendorff's Annalen, cxix. 1863, p. 247.

Fig. 1



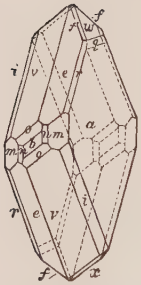


Fig. 2.

Fig. 2 shows a combination of all the forms found upon the Cornish crystals. The faces *f* and *q* are new. *f* is a small, well-defined face between *w e* ; *q* a rounded face between *a w*.

	Calculated.		Observed.	
	°	′	°	′
w f	24	38½	24	36
w q	31	14½	31	48 approx.

With the exception of *b*, *o*, *m*, *w*, the faces are somewhat uneven, and do not give good reflections.

The measured angles agree closely with those of Kokscharow. The following are some of the best:—

			Kokscharow.	
	°	′	°	′
b m	46	39	46	41½
b o	34	4	33	55
o m	35	58	35	58
w m	55	27	55	43
w x	93	0	93	1
b v	53	4	53	22

The measurements, however, though sufficient for the identification of the forms, are not good enough for the accurate determination of elements.

A crystal often has projecting from the faces, *v*, *e*, &c. corners of small crystals, which are united with itself by twinning upon the face *a*.

Connellite.

Several very fine specimens of this rare and beautiful Cornish mineral from Marke Valley and Camborne have lately been added to the British Museum Collection.

In comparison with what has formerly been found the crystals on the specimens from the latter locality are gigantic, some attaining a length of 2 to 4 mm., and having the terminal faces as much as 1 mm. in breadth.

The crystals are lustrous, and appear of a deeper blue than is common, owing to their greater thickness. They are closely united in radiating groups so as to form botryoidal and rounded masses. Isolated needles when they occur are small.

The matrix of the specimens is cuprite, with which are associated malachite and chrysocolla, the former occurring both massive and well crystallised. Chalcophyllite also appears on the Marke Valley, Brochantite and Chessylite on the Camborne specimens. Measurements made upon these crystals do not differ appreciably from those made upon minute needles by Prof. Maskelyne in 1863 (*Phil. Mag.* xxv. p. 39), and the habit of the crystals is that shown in Fig. 2, Plate II. of his description, but generally with the addition of the prism *b* $\{2\bar{1}\bar{1}\}$ ∞P truncating the edges of *a* $\{10\bar{1}\}$ ∞P2.

The scalenohedral faces *o w* $\{9\bar{4}\bar{2}, 46\bar{7}\}$ are not to be found upon these crystals, although they seem to be so characteristic of the little needles previously described.

But one specimen is remarkable for a totally distinct habit of crystallisation. The Connellite here occurs in stout prisms *a b*, capped by the basal plane alone; the latter, however, is rounded and uneven, showing a tendency to form faces which are slightly inclined to the true basal plane. On this specimen, as in the case of the others, the crystals are mostly grouped so as to form rounded masses, but also occur isolated, and of the same habit.

One crystal has been found showing a combination of the prisms, hexagonal pyramid, and basal plane.

Notes on Northern Minerals.

By Thos. Wallace, Esq., of Inverness.

(Communicated by the Local Secretary for Scotland.)

[Read June 16th, 1885.]

Barytes at Loch *Bhruithaich* (Bruiach).

My attention was first directed to this rock by Mr. Cruickshank, clerk of works at Beaufort Castle, in July of last year, when, from the description he gave of it, I ventured to pronounce it barytes. Specimens were soon after this put into my hands by Mr. Cruickshank, when I found that my conjecture was a correct one. There was another mineral associated with the barytes, of which we will speak afterwards. The specimens received were so very fine, that I resolved to visit the locality to be able to describe its surroundings and procure specimens for myself. This I did in May last in company with two of my colleagues and Mr. John Ross, one of Lord Lovat's gamekeepers, and who I believe was the first to call attention to this new locality.

General Description of Locality.

Loch Bruithaich, on the south shore of which this rock was found, is on Lord Lovat's property, and situated nine miles west of Beauly, with no regular road, however, within four miles of it. It lies encircled by hills in the very centre of one of the most interesting districts in the north, whether looked at geologically or archæologically; but more especially the latter. The entire district is literally covered with tumuli, hut-circles, vitrified forts, and cup-marked stones. Every rising ground, in fact, seems to have been occupied as a place of defence by the primitive Celtic inhabitants. The loch is 942 feet above average sea-level, and contains an island with the remains of a crannoge, the position of which will be easily found with the aid of the accompanying map.

Geology.

By reference to the same map, the whole district from Beauly to the loch will be found covered with Old Red Sandstone. Around Beauly it furnishes capital building materials, the whole of Beaufort Castle, lately erected, being built of it.

As we proceed westwards, the lower Old Red Conglomerate begins to show itself at the surface at Kilmorack, and continues westward to Loch Bhruithaich, where it is bounded by the underlying metamorphic rocks. The old red surrounds the loch on the north, south, and east, while the west is bounded by the metamorphic rock. We might almost say that this loch occupies a basin in the Old Red Conglomerate measuring 1¼ miles long by half a mile broad.

The barytes is interbedded with the conglomerate at the south-east corner of the loch. It is exposed on the face of the cliff, and can be traced into the loch for a distance of twelve or fourteen yards.

Both conglomerate and barytes dip to the S.S.E. at an angle of 56°.

The thickness of the barytes bed varies from 12 to 14 or 15 inches.

It has an associated mineral of a semi-transparent nature, very friable, and one or two specimens showed a bluish tint resembling fluor spar.

I have sent specimens of both minerals to Mr. Ivison Macadam, who has kindly undertaken an analysis of them, which I hope will be in time to accompany these notes.

The only other locality known to me in the north where barytes is found is in Gollachy Burn, in the parish of Engie, Banffshire.*

This is one of three places north of the Grampians where we have contemporaneous volcanic rocks in the lower Old Red Sandstone. The other places are Rhynie, near Huntly, and the Shetland Islands.

At Gollachy, a thin vein of barytes runs through the broken rock that overlies the bed of diabase-porphyrite.

Note.—Mr. Anderson, in his *Guide to the Highlands*, says :—"Near Little Struay, half a mile from the bridge, a lead mine situate in a thick vein of heavy spar, traversing gneiss, was some years ago (1847) opened by Lord Lovat, but for the present it has been abandoned."

Graphic Granite.

The gneiss of Kirkhill differs petrologically in different localities. At one place it is a hard compact contorted rock; at another it can be split into good roofing material; at another it assumes the form of a highly brecciated granitic rock, which in many places develops into graphic granite.

The arrangement of felspar in the latter is peculiar, being broken up

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* *Geol. Trans.* Vol. iii. Part iii. p. 336.

into small pieces, which assume a laminar structure. This arrangement of the felspar with the quartz filling up the interstices produces the graphic form of granite. According to Lyell, "the crystals of felspar appear to have been formed first, leaving the space between them now occupied by the darker coloured quartz."

The other localities known to me in the north are Portsoy, Foyers, Lentran, Rispond (Durnen), Lairg, and Achnaclaich (Ardron).

Limestone of Kirkhill.

There is a considerable development of limestone interbedded with the metamorphic rocks of this district. Quarries have been wrought, but now entirely disused, at Kirkton, Blair-na-henachie, Wester Chines, and Rebeg.

At the latter place this industry was very successfully carried on for a good many years. The kilns were very skilfully constructed on an unusually large scale for this district. Great quantities were shipped, and for this purpose a canal was cut by the late proprietor.

The lime from this quarry was particularly adapted for building purposes.

The same limestone is found in Glenurquhart, Foyers, and Strathnairn.

It presents a variety of character, from soft argillaceous to highly crystalline forms. Different minerals are found associated with it in several places :—

At Wester Chines	...	Tourmaline.
,, Rebeg	...	Abriachanite* and reddle or raddle.
,, Foyers	...	Graphic Granite.
,, Glenurquhart ...	...	Allanite, pyrrhotite, sphene, zoisite, kyanite, Edenite, tremolite, actinolite, &c.

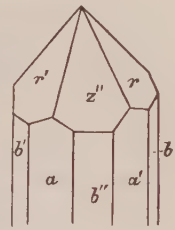
* For analysis see *Min. Mag.* Vol. III. pp. 65 and 66.

Connellite from Cornwall.

Note by Dr. C. O. Trechmann.

THE crystals are of a similar length, though often considerably thicker than those described by Prof. Maskelyne (*Phil. Mag.* Jan. 1863), and his general description applies to those under consideration.

They are, however, ill-adapted for measurement, as single perfect crystals are rare. As a rule several crystals are longitudinally attached to one another, with slight radial divergence, in such a manner that it becomes difficult or impossible to discriminate between the reflections of their minute faces.



The faces of the prismatic zone are rarely perfect, but more or less curved, and in some cases the pyramidal faces are quite rough.

The following is the result of the examination of two crystals, the first of which showed all the twelve faces of the forms *a* and *b*, while the second possessed two very brilliant pyramidal faces that gave distinct reflections:—

	Miller.	*Naumann.*
Forms—		
r	100	P
z	$\bar{1}22$	
a	$10\bar{1}$	∞P2
b	$2\bar{1}\bar{1}$	∞P
	C. O. T. measured.	*Maskelyne calculated.*
a b =	30° approx.	30°0′
r z'' =	47°31′	47°10′
r b'' =	66°30′	66°25′

Combinations: *r*, *z*, *a*; *r*, *z*, *a*, *b*.

The bipyramidal form observed by Maskelyne was not developed on these crystals.

There is no doubt about the identity of this mineral with the Connellite described by Maskelyne, and it is interesting to note that its hexagonal symmetry has received a final confirmation by Bertrand (*Bull. de la Soc. Mineralog.*, 1881, IV. 88), who examined the cross section of a crystal and found it uniaxal.

On the Chemical Composition of some Samples of Graphite from Knock, Aberdeenshire.

By W. Ivison Macadam, F.C.S., F.I.C., &c. Lecturer on Chemistry, School of Medicine; and Professor of Chemistry, New Veterinary College, Edinburgh.

[Read June 16th, 1885.]

THE proportion of actual carbon varies much in different samples. Some portions are stated to have analysed as high as 75 per cent., but, as will be noticed from the figures given below, the carbon may be much lower.

	1	2	3
Carbon	17·61	22·85	32·76
Moisture and trace of volatile matter ...	4·04	5·32	6·28
Ash	78·35	71·83	60·96
	100·00	100·00	100·00

The material occurs in the railway cutting near Rothiemay station.

The carbon was estimated by fusion with an alkali, after extraction of the soluble portion with dilute acid and weighing the dried residue. This residue was afterwards ignited in a current of pure oxygen, and the carbonic anhydride weighed and calculated into carbon.

Analysis of a Sample of Strontianite from Strontian, Argyllshire.

By W. Ivison Macadam, F.C.S., F.I.C., &c. Lecturer on Chemistry, School of Medicine; and Professor of Chemistry, New Veterinary College, Edinburgh.

[Read June 16th, 1885.]

THE samples to which this note refers were freshly cut from the quarries at Strontian. The mass differs much in quality, but is largely made up of the usual acicular groups. The colour of the mass as received varied, according to the composition, from a slight green shade where Strontianite predominated, to the more pure white of barium and calcium compounds.

The analyses were made from various portions, No. 1 being the selected Strontianite, No. 2 the more white portion of the mass. The results were as follows:—

		1	2
Strontium carbonate	...	94·502	56·601
Barium carbonate	...	0·214	0·051
Magnesic carbonate	...	—	0·416
Calcium carbonate	...	4·819	6·814
Plumbic sulphide	...	—	1·071
Strontium sulphate	..	—	21·248
Barium sulphate	...	—	10·014
Calcium sulphate	...	—	3·638
		99·535	99·853

The figures in analysis No. 1, when recalculated to the proportions of strontium oxide (Strontia), lime and carbonic anhydride, give the following results:—

Strontia	SrO	66·312
Lime	CaO	2·702
Baryta	BaO	0·166
Carbonic anhydride ...	CO_2	30·355
		99·535

These results do not differ materially from those quoted by Dana, as analyses by Stromeyer, Thomson and Klaproth, of the mineral as found at Strontian.

Analysis No. 2 on recalculation yields:—

Strontia	SrO	...	51·660
Baryta	BaO	...	6·608
Lime	CaO	...	5·311
Magnesia	MgO	...	0·198
Lead	Pb	...	0·927
Sulphur	S	...	0·144
Sulphuric anhydride ..	SO_3	...	14·853
Carbonic anhydride ...	CO_2	...	20·152
			99·853

I am not aware of any published results corresponding to this analysis of the crude mass. The proportions of the various minerals, as given above, have been calculated in the states of combination in which they evidently occur. In making the calculations I have been guided by the solubilities of the substances—weak acid dissolving out the carbonates, &c.

The carbonic anhydride found by actual analysis agreed with this assumption, whilst the insoluble sulphuric acid corresponded with the proportions of Strontia, &c. found after fusion, &c. of the portion insoluble in acids.

On the Chemical Composition of Butyrellite (Dana).

By W. Ivison Macadam, F.C.S., F.I.C., &c. Lecturer on Chemistry, School of Medicine; and Professor of Chemistry, New Veterinary College, Edinburgh.

[Read June 16th, 1885.]

IN DANA'S *System of Mineralogy*, 5th Edition, 1883, page 747, the following description of this substance is given:—"Crystallisable in needles; butter-like in consistence; colour, white; melting point of impure native material, 47°, Brazier; but of material after solution in alcohol, 51°, Luck; 52°-52°·7, Brazier; easily soluble in alcohol or ether."

"Comp. $C_{32}H_{64}O_4$, Brazier = Carbon 75·0, hydrogen 12·5, oxygen 12·5 = 100, and like palmitic acid in ratio. The following are Williamson's analyses:—Nos. 1, 2, were the uncrystallised butyrite; 3, that obtained by combination with potash (with which it forms a kind of soap) and a separation afterwards with acid:—

	C.	H.	O.
1. Uncrystallised	73·78	12·50	13·72 = 100
2. ,, ...	73·89	12·37	13·74 = 100
3. From Potash solution ...	75·05	12·56	12·39 = 100

Obs.—From the peat bogs of Ireland."

The only other notice of the substance with which I shall deal is one which occurs in Vol. XIX. of the *Proceedings of the Manchester Literary and Philosophical Society*, and is contained in a paper written by Mr. John Plant, F.G.S., &c. entitled *Bog Butter (Butyrellite) from Co. Galway, Ireland.* In this paper the author calls the substance a "mineral resin," and on page 70 says, "By the aid of scientific analysis, the substance called bog butter can be shown to be a perfectly natural production, arising from the decomposition of the vegetable matters growing the peat or bog," and "it is affirmed that the butter is sometimes found in small wooden kegs in bogs along the coast."

Following the advice of the last named author, I have submitted several samples of the bog butter to rigid chemical analysis, with the following results.

The samples collected for the investigation were ten in number, and were obtained as stated below.

No. 1.—From Antiquarian Museum, Edinburgh; found *in a keg* in Glen Gell, Morvern, Argyllshire.

No. 2.—From Co. Galway; collection of John Plant, Esq., F.G.S., and sample referred to in his paper.

No. 3.—Locality unknown; from a "Mether" in the Museum of Science and Art, Edinburgh.

No. 4.—Locality unknown; from the Museum of the Royal Irish Academy, Dublin.

No. 5.—Broora Bog, County Derry, Ireland (1830); from the Belfast Academy Museum.

No. 6.—County Down, Ireland; from the Belfast Academy Museum.

No. 7.—Bog near Stranoant House, Co. Antrim, Ireland; from the Belfast Academy Museum.

No. 8.—Kerry, Ireland; author's collection.

No. 9.—Locality unknown; from Mayne collection, Museum of Science and Art, Edinburgh.

No. 10.—Moss of Strathmore, Parish of Farr, Sutherlandshire, Scotland; Duke of Sutherland's collection, Golspie.

Sample 1 was a white solid, friable and greasy to the touch, with a cheese-like smell. Somewhat darkened on exposed surface. On the application of a heat of 100° C. (212° F.) the material melted readily to a clear yellow liquid, with floating solid particles very readily soluble in ether, and yielded, after evaporation at ordinary temperatures, a hard, slightly yellow mass, which on heating became a clear liquid with a yellow shade of colour. Fusing point 42°·2 C.; the ash of the original substance contained phosphoric acid.

Sample 2 was a white friable solid, somewhat greasy to the touch and with an odour resembling cheese. On heating, the material melted quickly to a clear yellow liquid with floating solid particles. Ether readily dissolved the sample, and on evaporation a hard yellow solid was obtained. Fusing point 47°·2 C.

Sample 3.—White, slightly friable, greasy, cheese-like smell. Heat readily melted the substance to clear yellow liquid with floating solid particles. Ether solution on evaporation gave a rich yellow solid. Fusing point 36°·1 C.

Sample 4.—White and very friable, greasy, cheese-like smell. Melted on application of heat to a clear slightly yellow liquid. Ether gave a hard white solid. Fusing point 47°·2 C.

Sample 5.—Strong yellow colour, very slightly friable, cuts with knife, greasy, cheese-like smell. Heat readily melted the sample to a rich yellow oil with few floating particles. Ether gave a yellow hard mass. Fusing point 46°·1 C.

Sample 6.—White and very greasy, could be moulded in fingers, butter-like smell. Melted to a clear slightly yellow liquid with floating solid particles. Ether gave a rich yellow and hard mass. Fusing point 37°·6 C.

Sample 7.—Rich yellow colour, very slightly friable, greasy, butter-like smell. On heating, yielded a clear rich yellow oil with floating solid portions. Ether gave a hard solid with rich yellow colour. Fusing point 36°·1 C.

Sample 8.—White, very friable, slightly yellow, greasy, butter-like smell. Melts very readily to a clear very slightly yellow liquid with floating solid particles. Ether gave a hard almost white substance. Fusing point 46°·6 C.

Sample 9 was a white, slightly yellow, greasy solid, with an odour resembling butter. Very friable. Melted readily to a clear slightly yellow liquid with floating solid particles. Purification by means of ether gave a hard almost white solid, melting at 46°·6 C.

Sample 10 was a white friable solid, with a cheese-like smell. Readily melted to a clear slightly yellow liquid. After solution in ether the resulting solid was white with a slight yellow tinge, and melted at 46° C.

The preliminary qualitative examination disclosed the presence of (1) fat, fatty acids, or material soluble in ether; (2) of a portion insoluble in ether but of an organic nature; (3) of a sugar, giving all the tests for the variety present in ordinary milk; and (4) of a residual ash, which in all cases contained a proportion of phosphoric acid.

The results of the quantitative analyses of the above constituents will be found on Table A., whilst the ultimate analyses of the samples will be found on Table B. and can readily be compared with the published analyses as given in Dana's *Mineralogy* and abstracted on Table C.

TABLE A.—ANALYSES OF SAMPLES OF BUTYRELLITE.

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.	No. 8.	No. 9.	No. 10.
Water	2·322	0·528	1·043	0·303	0·788	3·587	0·947	2·562	1·369	0·918
Portion soluble in Ether	97·252	98·943	96·308	98·813	95·468	91·517	97·194	93·955	97·260	98·452
Organic matter, insoluble in Ether	0·379	0·469	2·287	0·828	3·677	4·556	1·847	3·385	1·233	0·532
Ash or Mineral matter	0·047	0·058	0·361	0·055	0·065	0·334	0·011	0·096	0·137	0·084
	100·000	99.998	99·999	99·999	99·998	99·994	99·999	99·998	99·999	99·990

TABLE B.—ULTIMATE ANALYSES OF BUTYRELLITE.

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6	No. 7.	No. 8.	No. 9.	No. 10.
Carbon	73·86	73·55	74·21	75·13	73·37	73·72	75·48	73·55	75·12	74·56
Hydrogen ...	12·48	12·33	12.52	12·56	12·14	12·88	12·25	12·74	12·31	12·68
Oxygen	13·66	14·12	13·27	12·31	14·49	13·40	12·27	13·71	12·57	12·76
	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00

TABLE C.—ULTIMATE ANALYSES OF BUTYRELLITE.

	Williamson.		*Brazier.*	*Greg and Lettsom.*	
	No. 1.	No. 2.		No. 1.	No. 2.
Carbon	73·78	73·89	75·0	73·33	75·65
Hydrogen ...	12·50	12·37	12·5	12·46	12·35
Oxygen	13·72	13·74	12·5	13·71	12·00
	100·00	100·00	100·0	99·50	100·00
Melting point	50°C.		47°C.	51°·1 C.	

TABLE A.—The following examination was made on the results of the purification by ether:—

1.—The ether solution was evaporated spontaneously, and afterwards heated on the water bath till a constant weight was established. The material was then treated with caustic soda and boiled. Salt was added to the mixture, and the separated curd removed and treated, after washing in small quantities of cold water, with sulphuric acid. The material so separated was allowed to stand until a firm cake was formed, which was then removed, and was found to consist of acids in all ways resembling those in ordinary butter. The liquid, after saponification with soda, was evaporated to almost dryness, and separated from the salt, which crystalised out. On exposure to heat the material evolved the odour of Acrolein, one of the products of the decomposition of glycerine by heat.

These experiments prove that the portion of the Butyrellite soluble in ether corresponded in all respects to the body obtained under like conditions from ordinary butter.

2.—The organic portion insoluble in ether was found to be to a slight extent soluble in water, and the solution on concentration gave faint but distinct evidence of the presence of *milk sugar* in very small proportions.

The portion left after treatment with water contained nitrogen, and gave when burned the peculiar "feathery" odour of burning cheese. *These tests are taken as indicating coesin similar to that found in milk.*

3.—The ash or mineral portion, as already stated, contained phosphoric acid in traces.

Taking all the above results into consideration, I am decidedly of opinion that Butyrellite has no claim to be called a "mineral," or to appear in text-books of mineralogy. The fact that a large number of the samples of this substance were found, and still exist in barrels, and can be seen by any one who takes the trouble to visit the Museum of Antiquaries of Scotland, Edinburgh; or the Dublin Museum, or the Belfast Museum; that samples have been found wrapped in cloth or bearing the marks of woven cloth and covered with rushes or other plant fibre; that the substance is only found in peat bogs (noted for their powers of arresting decomposition); and lastly, that tradition speaks of the butter-dyke or butter-safe being dug in bogs, all point to the material being of veritable animal origin, and having nothing in common with the mineral kingdom.

But outside of all this mass of evidence, chemical, circumstantial, and traditional, the butter—for butter it is—has its own story to tell. One and all of the samples on being broken across, or still better when treated with ether, yield to the observer a number of *hairs*, which on being examined

under the microscope can be readily identified as resembling in all respects *cow's hair*, and in one case at least the very same bog has furnished not only *bog butter* but *heads of oxen*—these heads having still attached to them hairs exactly corresponding to those imbedded in the butter.

As to how these kegs and masses of butter found their way into the positions from which they are now obtained we cannot here discuss; it is sufficient for our purpose to show that the material is not of mineral or even of resin origin, but of undoubted animal derivation. The material should therefore be erased from mineral lists.

On an Occurrence of Rare Copper Minerals from Utah.

By G. S. Mackenzie, Ph.D., F.I.C.

[Read 16th June, 1885.]

IN the American Eagle Mine, Utah Territory, occur in intimate association with olivenite and other copper compounds, two copper minerals of an interesting and rare composition.

Conichalcite.—Covering the surface of often large pieces of more or less friable mixed arseniates, sometimes forming a complete green coating, are numbers of beautiful emerald-green globules. In consequence of the firm adherence of the base of the globules to the underlying gangue matter, it was difficult to obtain material pure enough for analysis, and therefore the results given below lay no claim to great accuracy.

		Conichalcite from Spain.
CuO	28·59	31·76
CaO	19·67	21·36
MgO	0·61	—
ZnO	2·75	—
Ag	·29	—
As_2O_5	39·80	30·68
P_2O_5	0·20	8·81
V_2O_5	—	1·78
H_2O	5·55	5·61
Fe_2O_3	0·45	—
CO_2	0·98*	—
Quartz	1·11	—
	100·00	100·00

* By difference.

The ferric oxide was derived from adhering gangue matter. The carbon dioxide was most likely combined with lime, as the temperature required for its expulsion was very much higher than that at which all the water was driven off.

The silver seems to be present in an oxidised state as silver arseniate, since nitric acid takes it all into solution, and no sulphide or native silver could be detected.

This mineral resembles very much conichalcite, found hitherto only in Andalusia in Spain. The analysis, as represented in Dana's system of mineralogy, is given above for comparison. The Utah mineral differs from the Spanish one in containing no vanadium, and having seemingly part of the copper replaced by zinc. Phosphorus is also almost wanting.

Chenevixite.—Scattered in patches throughout such parts of the ore as occur in hard lumps is a greenish opaque body, with little or no lustre, corresponding very well in composition with analysis of chenevixite from Cornwall, as given in Dana's *Mineralogy*.

		Chenevixite from Cornwall.
CuO	26·88	31·70
CaO	0·55	0·34
MgO	0·23	—
Fe_2O_3	26·94	25·10
Al_2O_3	1·17	—
As_2O_5	34·62	32·20
P_2O_5	—	2·30
H_2O	9·25	8·66
Quartz	·71	—
	100·35	100·30

Before the blowpipe the two minerals react the same, giving off arsenical fumes and leaving a black magnetic residue.

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By H. A. Miers, M.A.,

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LIST OF ABBREVIATIONS USED IN INDEX.

Abh. Ges. Gött.	Abhandlungen d. kön. Ges. d. Wissenschaften zu Göttingen.
Abh. Nat. Ges. Görl.	Abhandlungen d. naturforschenden Gesellschaft zu Görlitz.
Abh. Nat. Ver. Brem.	Abhandlungen heraus. naturwissens. Vereine zu Bremen.
Abh. Senck. Ges.	Abhandlungen der Senckenbergischen naturforschenden Gesellschaft. Frankfurt-a-M.
Act. Ac. Bord.	Actes de l'Académie nationale des sciences, belles lettres et arts de Bordeaux. Bordeaux.
Act. Un. Lund.	Acta Universitatis Lundensis. Lund.
Ann. Mus. Gen.	Annali del Museo Civico di Storia Naturali di Genova. Genova.
Ann. Nat. Hist.	The Annals and Magazine of Natural History. London.
An. Soc. Esp. Hist. Nat.	Anales de la Sociedad Española de Historia Natural. Madrid.
Anz. Ak. Wien.	Anzeiger der k. Akademie der Wissenschaften. Wien.
Arch. Néerl.	Archives néerlandaises des sciences exactes et naturelles. Haarlem.
Arch. Sc. Phys. Nat.	Bibliothéque Universelle. Archives des Sciences Physiques et Naturelles. Genève.
Arch. Ver. Fr. Meck.	Archiv des Vereins der Freunde der Naturgeschichte in Mecklenburg. Güstrow.
Art.	Artificial.
Ass. Fr.	Association française pour l'avancement des sciences. Paris.
Att. Ac. Gioen.	Atti dell' Accademia Gioenia di Scienze Naturali in Catania. Catania.
Att. Ac. Linc.	Atti della R. Accademia dei Lincei (memorie della classe di scienze fisiche, matematiche e naturali). Roma.
Att. Ac. Pont.	Atti dell' Accademia Pontificia di Nuovo Lincei. Roma.
Att. Ac. Tor.	Atti della Reale Accademia della Scienze di Torino.
Att. Ist. Ven.	Atti del reale Istituto Veneto di Scienze, Lettere ed Arto. Venezia.
Att. Soc. It. Mil.	Atti della Società Italiana di Scienze Naturali. Milano.
Att. Soc. Nat. Mod	Atti della Società dei Naturalisti di Modena. Modena.
Att. Soc. Tosc.	Atti della Società Toscana di Scienze Naturali. Pisa.
Ber. Böhm. Ges.	Sitzungsberichte d. k. böhm. Gesellschaft der Wissenschaften. Prag.
Ber. Chem. Ges. Berl.	Berichte der deutschen chemischen Gesellschaft zu Berlin.
Ber. Nat. Ges. Dorp.	Sitzungsberichte der naturforschenden Gesellschaft. Dorpat.
Ber. Nat. Ges. Halle.	Bericht über die Sitzungen der Naturforschenden Gesellschaft zu Halle.
Ber. Nat. Ges. Leipz.	Sitzungsberichte der naturforschenden Gesellschaft zu Leipzig.

Ber. Phys. Ges. Wurz. Sitzungsberichte der physikalisch medicinischen Gesellschaft zu Wurzburg.

Ber. Ung. Mathematische und naturwissenschaftliche Berichte aus Ungarn. Berlin

Bull. Ac. Belg. Bulletin de l'Académie Royale des Sciences Belgique. Bruxelles.

Comm. At. Bresc. Commentari dell' Ateneo di Brescia. Brescia.

Dansk. Vid. Selsk. Skr. Kongelige danske videnskabers Selskab (Skrifter). Copenhagen.

Denks. Ak. Wiss. Wien. Denkschriften der kaiserlichen Akad. der Wissenschaften. Wien.

Denks. Schw. Ges. Neue Denkschriften d. allgemeinen schweizischen Gesellschaft f. die gesammten Naturwissenschaften. Zürich.

Dingl. J. Dingler's Polytechnisches Journal. Stuttgart.

Eng. Min. J. The Engineering and Mining Journal. New York.

Földt. Köz. Földtani Közlöny. Budapest.

Geol. För. Geologiska Föreningens i Stockholm. Förhandlingar. Stockholm.

Geol. Mag. Geological Magazine. London.

Isis (Ber. and Abh.). Sitzungsberichte und Abhandlungen der naturwissenschaftlichen Gesellschaft Isis. Dresden.

Jahrb. Hamb. Anst. Jahrbuch der Hamburgischen wissenschaftlichen Anstalten. Hamburg.

Jahrb. Nass. Ver. Jahrbuch des Nassauischen Vereins für Naturkunde. Wiesbaden.

Jahresb. Ann. Buch. Ver. Jahresbericht des Annaberg-Buchholzer Vereins für Naturkunde. Annaberg-in-S.

Jahresb. Böhm. Ges. Jahresbericht d. k. Böhm. Gesellschaft der Wissenschaften Prag.

Jahresb. Nat. Ver. Rhein. Jahresbericht der Pollichia eines naturwissenschaftlichen Vereins der Rheinpfalz. Durkheim a-d-Hart.

Jahresh. Ver. Württ. Jahreshefte des Vereins für vaterlandische Naturkunde in Württemberg. Stuttgart.

J. Ac. Sc. Lisb. Jornal de Sciencias Mathematicas Physicas e Naturaes publicado sob os auspicios da Academia Real das Sciencias de Lisboa.

J. Chem. Soc. Journal of the Chemical Society. London.

J. Mic. Soc. Journal of the Royal Microscopical Society. London and Edinburgh.

J. Nat. Ges. Zür. Vierteljahrschrift der schweizerischen naturforschenden Gesellschaft in Zürich. Zürich.

J. Queck. Journal of the Queckett Microscopical Club. London.

LOTOS.	Lotos Jahrbuch für Naturwissenschaft. Prag.
MAANDBL.	Maandblad voor Naturwetenschappen. Amsterdam.
MEDD. NAT. FOR. COP.	Videnskabelige Meddelelser fra den naturhistoriske Forening i Kjøbenhavn. Copenhagen.
MÉM. AC. AM.	Mémoires de l'Académie des Sciences, des Lettres, et des Arts d'Amiens.
MÉM. AC. BELG.	Mémoires de l'Académie Royale des Sciences, des Lettres, et des Beaux-arts de Belgique. Bruxelles.
MEM. AC. BOL.	Memorie della Accademia delle Scienze dell' Istituto di Bologna.
MÉM. AC. SAV.	Mémoires de l'Académie des Sciences, Belles Lettres, et Arts de Savoie. Chambéry.
MÉM. AC. ST. PET.	Mémoires de l'Académie Impériale des Sciences de St. Petersbourg.
MEM. AC. TOR.	Memorie della Reale Accademia della Scienze di Torino.
MEM. SOC. NAT. MOD.	Memorie della Società dei Naturalisti di Modena. Modena.
MIN. MAG.	Mineralogical Magazine and Journal of the Mineralogica-Society. London.
MITTH. NAT. VER. FRANK.	Monatliche Mittheilungen des naturwissenschaftlichen Vereins. Frankfurt-a-Oder.
MITTH. NAT. VER STEIER.	Mittheilungen des naturwissenschaftlichen Vereines für Steiermark. Graz.
MITTH. UNG. GEOL. ANST.	Mittheilungen aus dem Jahrbuche der kön. Ungarischen geologischen Anstalt. Budapest.
NAT. TIDDS.	Naturhistorisk Tiddsskrift. Copenhagen.
NATURE.	Nature. London and New York.
NEPS. TERM. EL.	Nepszerü Termeszettudomanyi Elöadasok Gyüjlemenyi. Budapest.
NORSK. VID. SELS. SKR.	Det kongelige Norske Videnskabers Selskabs (Skrifter). Throndhjem.
NOV. ACT. AC. CAES.	Nova Acta Academiae Caesareae Leopoldino-Carolinae Germanicae Naturae curiosorum. Halle.
NOV. ACT. SOC. UPS.	Nova Acta Regiae Societatis Scientiarum Upsaliensis. Upsala.
NYT. MAG.	Nyt Magazin for Naturvidenskaberne. Christiania.
PHIL. TRANS.	Philosophical Transactions of the Royal Society of London.
PREIS. JAB. GES.	Preisschriften von der Jablonowski'schen Gesellschaft zu Leipzig. Leipzig.
PROC. AM. PHIL. SOC.	Proceedings of the American Philosophical Society. Philadelphia.
PROC. COTTES. NAT.	Proceedings of the Cotteswold Naturalists' Field Club. Gloucester.
PROC. IRISH AC.	Proceedings of the Royal Irish Academy. Science. Dublin.
PROC. PHIL. SOC. GLASG.	Proceedings of the Philosophical Society of Glasgow. Glasgow.

PROC. PHIL. SOC. MAN. Proceedings of the Manchester Literary and Philosophical Society. Manchester.
PROC. ROY. SOC. Proceedings of the Royal Society of London.
PROC. ROY. SOC. ED. Proceedings of the Royal Society of Edinburgh.

PSEUD. Pseudomorph.
Q. J. MIC. SC. Quarterly Journal of Microscopical Science. London.

RAD. JUGO. AK. Rad Jugoslavenske Akademije Znanosti i Umjetnosti. Zagrebu.
RENDIC. AC. BOL. Rendiconto delle sessione dell'Accademia Reale delle Scienze dell' Istituto di Bologna. Bologna.
RENDIC. IST. LOMB. Reale Istituto Lombardo di scienze e lettere. Rendiconti. Milano.
REP. BRIT. ASS. Report of the British Association for the Advancement of Science. London.
REP. DEV. ASS. Report and Transactions of the Devonshire Association. Plymouth.
REV. Q. SC. BR. Revue des Questions scientifiques. Bruxelles.

SCHR. GES. DANZ. Schriften der naturforschenden Gesellschaft zu Danzig. Danzig.
SCHR. PHYS. GES. KÖNIGS. } Schriften der Physikalisch-ökonomischen Gesellschaft. Königsberg.

TERMES. FÜZET. Termeszetrajzi Füzetek kiadja a magyar nemzeti muzeum. Budapest.
TERMES KÖZ. Termeszettudomanyi Közlöny. Budapest.
TRANS. DEVON. ASS. Devonshire Association for the Advancement of Science, &c London and Plymouth
TRANS. GEOL. SOC. CORN. Transactions of the Royal Geological Society of Cornwall, Penzance.
TRANS. ROY. SOC. ED. Transactions of the Royal Society of Edinburgh. Edinburgh.

VERH. AK. VET. AMST. Verhandelingen der koninklijke Akademie van Vetenschappen. Amsterdam.
VERH. GEOL. REICHS. Verhandlungen der kaiserlich-königlichen geologischen Reichsanstalt. Wien.
VERH. GES. ERDK. Verhandlungen der Gesellschaft für Erdkunde zu Berlin.
VERS. MED. AK. AMST. Verslagen en Mededeelingen der koninklijke Akademie van Wetenschappen. Amsterdam.
VERH. NAT. VER. BRÜNN. Verhandlungen des naturforschenden Vereines in Brünn.
VERH. PHYS. GES. WURZ. Verhandlungen der physikalisch medicinischen Gesellschaft zu Wurzburg.
VERH. RUSS. MIN. GES. Verhandlungen der russisch kaiserlichen mineralogischen Gesellschaft zu St. Petersburg.
VERH. SCH. GES. ZÜR. Verhandlungen der schweizerischen naturforschenden Gesellschaft in Zürich. Zürich.

VERH. NAT. VER. KARLS. Verhandlungen des naturwissenschaftlichen Vereins in Karlsruhe.

ZTS. ANAL. CHEM. Zeitschrift für analytischen Chemie. Wiesbaden.
ZTS. ETHN. Zeitschrift für Ethnologie. Berlin.
ZTS. GEOL. GES. BERL. Zeitschrift der deutschen geologischen Gesellschaft. Berlin.
ZTS. NATURWISS. JENA. Jenaische Zeitschrift für Naturwissenschaft. Jena.

Abstracts.

H. Foerstner.—*Ueber künstliche physikalische Veränderungen der Feldspäthe von Pantelleria.* (*Zeits. f. Krystallographie u. Mineralogie* IX. p. 333.)

The felspars of Pantelleria are (1) potash plagioclase, and (2) soda-orthoclase.

(1). The Anorthic felspars form a chemical and crystallographical series from that of Mt. Gibele, for which $K_2O : Na_2O = 1 : 4 \cdot 29$, to that of Cuddia Mida, for which $K_2O : Na_2O = 1 : 2 \cdot 29$. With the exception of the first they all become optically oblique during or after heating to various temperatures, and the temperature required to produce the change decreases through the series from 300° to 86° in the case of the Cuddia Mida felspar.

The felspar of Mt. Gibele remains unchanged at 500°, as do the potash-plagioclases of other localities.

The plagioclase of Cuddia Mida, which is most easily transformed, is isodimorphous with, and stands very near to the soda-orthoclase in both form and composition, and simulates an oblique form by twinning; so that, as is also the case with boracite, leadhillite, leucite, and tridymite, these pseudosymmetrical twins assume optical properties corresponding to their form when they are heated.

On cooling, the extinction angle returns to its original value of about 2°, but the lamellations are permanently changed; the felspar of Cuddia Mida alone retains occasional oblique patches, and optical anomalies.

(2). The soda-orthoclase is unaltered while being heated, but during cooling becomes in parts optically anorthic, finally returning in part or entirely to its original character. During the cooling numerous varieties of lamellation and changes of extinction angle are produced.

The author regards potash and soda-felspar as isodimorphous, each having a stable and an unstable form; in the potash-plagioclase, therefore, the former is in its unstable modification, and only adopts the other when heated; the same is true of soda-felspar in the soda-orthoclase. The potash-plagioclase, therefore, originally crystallised in the oblique form (as boracite in the cubic), and was changed in cooling, with the exception of the variety mentioned above as unaltered by heating, which is also the farthest in the series from orthoclase. Of the two nearly identical

felspars, plagioclase from Cuddia Mida, and the soda-orthoclase (2), the latter probably crystallised more slowly and under less pressure than the former. The author found that by means of pressure he could induce in the soda-orthoclase the twin striations of a plagioclase, and lamellæ with oppositely inclined extinction angles. H. A. M.

C. Klein.—*Optische Studien am Leucit.* (*Nachrichten von der k. Gesellschaft der Wissenschaften zu Göttingen.* 1884, p. 421.)

Having shown in a previous paper that Leucite, which is generally regarded as tetragonal, becomes isotropic when heated, the author now pronounces the mineral to be rhombic, and concludes that it crystallised in the cubic system and became rhombic on cooling. It is not tetragonal because (1) twinning takes place on all the dodecahedron faces, and (2) no plane exactly plays the part of the basal plane in the tetragonal system.

Crystals of Leucite may consist either (A) of a single individual with interposed twin lamellæ, or (B) of three interpenetrating individuals so arranged that their basal planes form the cube faces of the compound (and apparently cubic) crystal. In case (A) one of the three cubic sections is characterised by more abundant twin lamellation and weaker double refraction than the other two, and corresponds to the basal plane ; in case (B) the three cubic sections are identical.

The results described in the paper are derived from sections carefully cut in *definite* directions. For example—In crystals of the class A *cubic sections* show blurred lamellæ parallel to the cube edges due to twinning on the 8 dodecahedron faces inclined to the section, and sharply defined lamellæ perpendicular to the edges, due to twinning on the 4 dodecahedron faces perpendicular to the section ; *octahedral sections* show blurred lamellæ parallel to the octahedron edges due to twinning on the 6 faces inclined to the section, and sharper lamellæ perpendicular to the edges due to twinning on the 6 faces perpendicular to the section ; *dodecahedral sections* show blurred lamellæ parallel to the dodecahedron edges due to twinning on the 8 faces inclined to the section, and sharp lamellæ parallel to the shorter diagonal of the dodecahedron face due to twinning on the 2 faces perpendicular to the section (the remaining two faces of the form being parallel to the section).

Icositetrahedral sections show blurred lamellæ in 4 directions due to twinning on the 10 faces inclined, and sharper lamellæ in one direction due to the 2 faces perpendicular, to the section.

Similar sections of crystals belonging to the class B show lamellations which are explained by the same twinning.

If sections are made in a crystal of the first class parallel to three dodecahedral faces in a zone, two of these sections must (if the crystal be rhombic) belong to the dome {201} and one to the prism {110} ; they are found to be distinguished by having their shorter and longer diagonals respectively the axis of greater optical elasticity. All the above facts lead to the conclusion that the mineral possesses rhombic symmetry, though in its geometrical and physical characters very near to the tetragonal or even to the cubic system. It has been by various authors ascribed with great plausibility to each of these three systems, and the author suggests an explanation when he points out that a crystal belonging to the class B will have rhombic, tetragonal, or cubic habit and characters, according as there is a predominance of one, two, or equally of all three of the individuals.

H. A. M.

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